PROCEEDINGS OF THE BIOLOGICAL SOCIETY OF WASHINGTON
116(2):293–300. 2003.

Diagnoses of hybrid hummingbirds (Aves: Trochilidae). 10. *Cyanomyia salvini* Brewster, 1893, is an intergeneric hybrid of *Amazilia violiceps* and *Cynanthus latirostris*

Gary R. Graves

Department of Systematic Biology, MRC-116, National Museum of Natural History, P.O. Box 37012, Smithsonian Institution, Washington, D.C. 20013-7012, U.S.A.

Abstract.—*Cyanomyia salvini* Brewster, 1893, collected in Sonora, Mexico, is shown to be a hybrid between *Amazilia violiceps ellioti* and *Cynanthus latirostris magicus,* whose breeding ranges overlap extensively in northwestern Mexico. This specimen represents the only known intergeneric hybrid between species currently placed in *Amazilia* and *Cynanthus* (Sibley and Monroe 1990).

The unique type of *Cyanomyia salvini* Brewster, 1893, was collected by John C. Cahoon at Nichosari, Sonora, Mexico, on 31 March 1887. Early references treat *C. salvini* as a valid species (Boucard 1895, Ridgway 1911, Cory 1918, Simon 1921), although only Ridgway's entry indicated a personal examination of the specimen. Griscom (1934:378) proposed a hybrid origin for *C. salvini* in his revision of *Amazilia violiceps*:

> "By inference I had always doubted the existence of another species of this genus [*Amazilia*] in Sonora. Geographically and faunally there is no basis for one, and the failure to duplicate the type in over 40 years has further significance, and in part at least strengthens this view. My late esteemed colleague Outram Bangs always supposed that *salvini* was of hybrid origin. A careful study of the color and structural characters of the type convinces me that *Cyanomyia salvini* Brewster is a hybrid between *Amazilia violiceps conjuncta* [= *Amazilia violiceps elliotí*] and *Cynanthus latirostris* Swainson."

Griscom's brief description was insufficient to make a convincing case for hybridization, but Peters (1945) and Phillips (1964) cited Griscom's treatment without substantive comment. A second hypothesis was introduced in a succinct footnote by Friedmann et al. (1950), who suggested that *Cyanomyia salvini* is an aberrant example of *Amazilia violiceps*. This idea was later endorsed by Weller & Schuchmann (1997) and Weller (1999), but neither of these references provided corroborating evidence. As a consequence, the taxonomic status of *Cyanomyia salvini* is still in doubt. Here I provide a taxonomic assessment of *Cyanomyia salvini* employing the methods and assumptions outlined in Graves (1990) and Graves & Zusi (1990), as modified by the findings of Graves (1998, 1999b).

Methods

The type of *Cyanomyia salvini,* (J. C. Cahoon field number 505), originally part of the William Brewster Collection (No. 24,124), was eventually cataloged in the Museum of Comparative Zoology, Harvard University (received in 1918, No. 224,124). The type was sexed as ♂ on the Brewster Collection label and appears to be in definitive plumage as judged by the absence of striations on the maxillary ramphotheca, the absence of distinctive buffy feather tips on the dorsal plumage, and the presence of a strongly iridescent coronal patch. Descriptions in this paper refer to definitive male plumage. I compared the type of *Cyanomyia salvini* with specimen series of *Calypte annae, C. costa, Selasphorus platycercus, S. rufus, S. sasin, Stellula calliope, Archilochus alexandri, Calothorax luciferi, He-*

Table 1.—Ranges (mean ± standard deviation) of measurements (mm) of wing chord, bill length, and rectrix length (R1–R5) of adult males of *Amazilia violiceps ellioti, Cynanthus latirostris magicus* and a probable hybrid, *Amazilia violiceps ellioti* × *Cynanthus latirostris magicus* (= type of *Cyanomyia salvini* Brewster, 1893; MCZ 224, 124).

Character	*Amazilia violiceps* N = 15–17	*Cynanthus latirostris* N = 14–15	*Cyanomyia salvini*
Wing	53.5–56.1 (54.6 ± 0.7)	48.4–51.9 (50.4 ± 0.8)	52.9
Bill	20.1–22.5 (21.4 ± 0.6)	18.7–21.6 (20.3 ± 0.8)	21.4
R1	26.3–29.3 (28.2 ± 0.8)	22.4–25.3 (23.8 ± 0.7)	27.7
R2	28.0–30.5 (29.4 ± 0.9)	23.9–27.0 (25.8 ± 0.7)	28.0
R3	28.3–31.4 (30.1 ± 1.0)	26.3–29.4 (28.6 ± 0.8)	29.1
R4	28.3–32.5 (30.7 ± 1.1)	28.7–32.4 (30.8 ± 1.0)	30.6
R5	28.8–32.6 (30.7 ± 1.2)	31.0–33.8 (32.5 ± 0.7)	31.2

liomaster constantii, Eugenes fulgens, Lampornis clemenciae, Amazilia beryllina, A. violiceps (including the type of *Amazilia violiceps conjuncta* Griscom, 1934; MCZ No. 224,112), *Hylocharis leucotis,* and *Cynanthus latirostris magicus,* all of which occur in Sonora, Mexico (Friedmann et al. 1950, Howell & Webb 1995), in the collections of the Museum of Comparative Zoology. Because the generic allocation of species traditionally placed in *Amazilia* by Peters (1945) is in flux, I use the species taxonomy of Sibley & Monroe (1990). Detailed descriptions and photographs of the type of *Cyanomyia salvini* were compared with series of the aforementioned species in the National Museum of Natural History, Smithsonian Institution, and with a supposed immature specimen of *Cyanomyia salvini* collected at Palmerlee, Cochise County, Arizona, on 5 July 1905 (Bishop 1906). The latter specimen (Field Museum of Natural History 160,998; wing chord = 53.4 mm; bill length = 21.2; R4 = 29.7; R5 = 29.9) appears to be a female *Amazilia violiceps* and will not be further discussed.

Measurements were taken with digital calipers and rounded to the nearest 0.1 mm: wing chord; bill length (from anterior extension of feathers); and rectrix length (from point of insertion of the central rectrices to the tip of each rectrix) (Table 1). Pairs of rectrices are numbered from the innermost (R1) to the outermost (R5). Scatter plots of measurements and least squares regression lines were used to illustrate size differences among specimens.

General color descriptions presented in Appendix 1 were made under natural light. I evaluated the color of the medial vane of the dorsal surface of R1 (7 mm from tip) with a calibrated colorimeter (CR-221 Chroma Meter, Minolta Corporation) equipped with a 3.0 mm aperture. The measuring head of the CR-221 uses 45° circumferential illumination. Light from the pulsed xenon arc lamp is projected onto the specimen surface by optical fibers arranged in a circle around the measurement axis to provide diffuse, even lighting over the measuring area. Only light reflected perpendicular to the specimen surface is collected for color analysis. Colorimetric data from iridescent feathers are acutely dependent on the angle of measurement, the curvature of plumage surfaces in museum skins, and the degree of pressure applied to the plumage surface by the Chroma Meter aperture. In

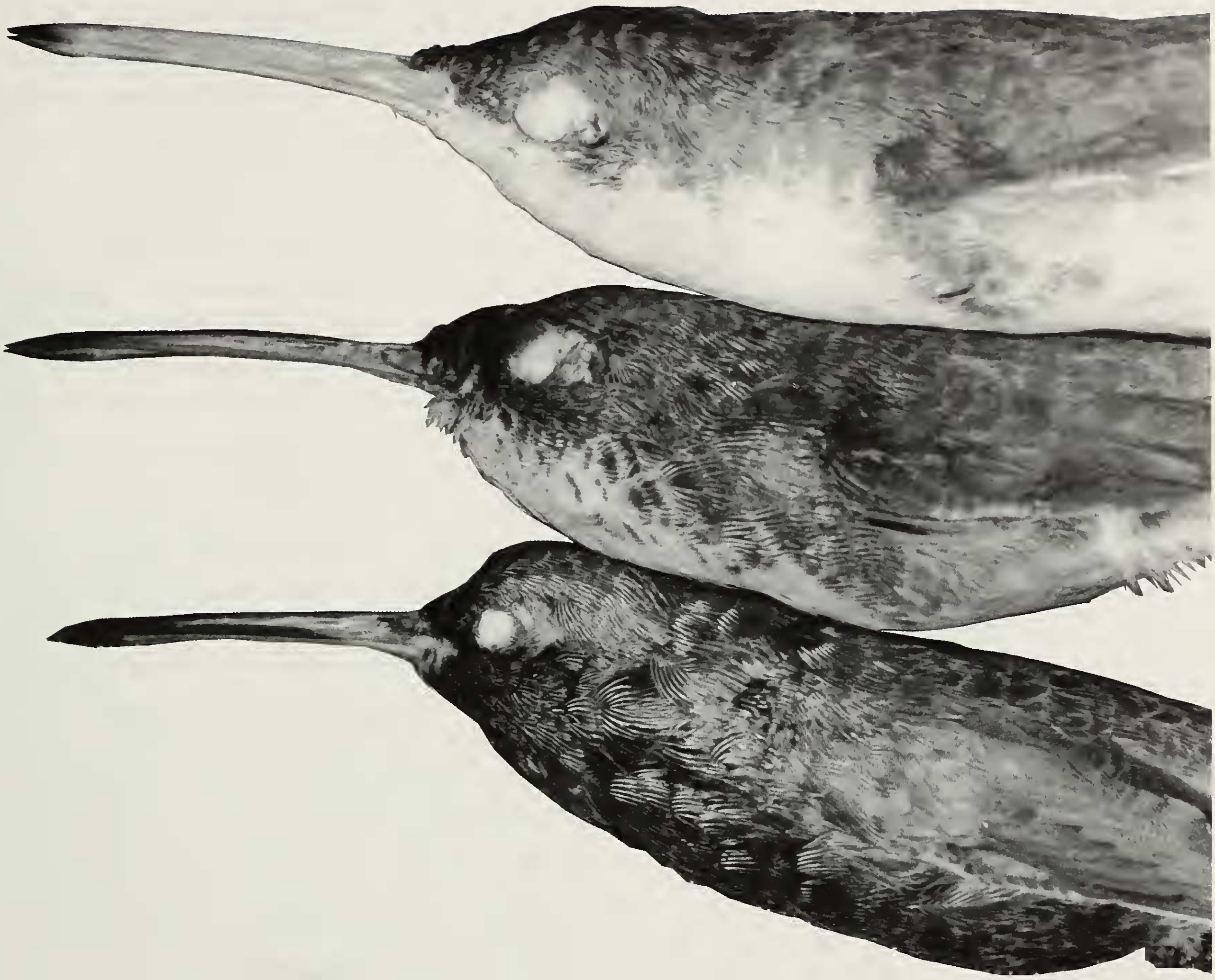

Fig. 1. Lateral views of males in definitive plumage: *Amazilia violiceps ellioti* (top), *Cynanthus latirostris magicus* (bottom), and a probable hybrid, *Amazilia violiceps ellioti* × *Cynanthus latirostris magicus* (= type of *Cyanomyia salvini* Brewster, 1893; MCZ 224,124).

order to reduce measurement variation, I held the aperture flush with the rectrix surface without depressing it. The default setting for the CR-221 Chroma Meter displays mean values derived from three sequential, in situ measurements. I repeated this procedure twice (five times for the type of *Cyanomyia salvini*), removing the aperture between trials. Thus, each datum summarized in Table 2 represents the mean of 6 (parental species) or 15 (type of *C. salvini*) independent colorimetric measurements.

Colorimetric characters were described in terms of opponent-color coordinates (*L, a, b*) (Hunter & Harold 1987). This system is based on the hypothesis that signals from the cone receptors in the human eye are coded by the brain as dark-light (*L*), green-red (*a*), and blue-yellow (*b*). The rationale is that a color cannot be perceived as red and green or yellow and blue at the same time. Therefore "redness" and "greenness" can be expressed as a single value, *a,* which is coded as positive if the color is red and negative if the color is green. Likewise, "yellowness" or "blueness" is expressed by *b* for yellows and $-b$ for blues. The third coordinate, *L,* ranging from 0 to 100, describes the "lightness" of color; low values are dark, high values are light. The more light reflected from the plumage, the higher the *L* value will be. Visual systems in hummingbirds (e.g., Goldsmith & Goldsmith 1979) differ significantly from those of humans and the relevance of opponent color coordinates to colors perceived by

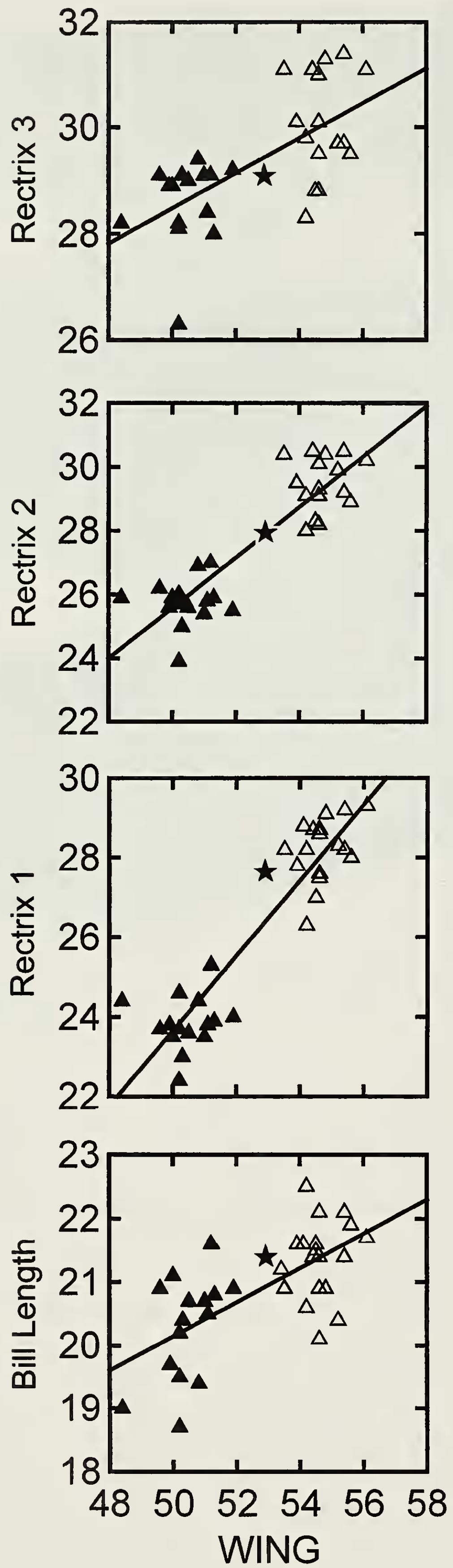

Fig. 2. Bivariate plots of measurements (see Table 1): *Amazilia violiceps ellioti* (hollow triangle), *Cynanthus latirostris magicus* (▲), and a probable hybrid, (☆) *Amazilia violiceps ellioti* × *Cynanthus latirostris magicus* (= type of *Cyanomyia salvini* Brewster, 1893; MCZ 224,124).

hummingbirds is unknown. In any case, the *L, a, b* color system permits plumage color to be unambiguously characterized for taxonomic purposes.

Results and Discussion

I considered three hypotheses proposed by previous authors—*Cyanomyia salvini* represents (1) a hybrid, *Amazilia violiceps* × *Cynanthus latirostris,* (2) an aberrant example of *Amazilia violiceps,* or (3) a valid species. For brevity I use the epithet, *salvini,* in the remainder of the paper.

I found no evidence that *salvini* represents a subdefinitive plumage or geographic variant of any known taxon. The possibility that *salvini* represents an aberrant plumage of *Amazilia violiceps* can be rejected because *salvini* has substantially shorter wings. All evidence is consistent with the hypothesis that *salvini* represents an intergeneric hybrid, *Amazilia violiceps* × *Cynanthus latirostris.* Several characters of *salvini* facilitate the identification of its parental species (Appendix 1): (a) brilliant bluish-purple crown; (b) white chin, throat, midline of breast and abdomen white; (c) greenish-blue subterminal spots or bars on white feathers at the lateral margins of the throat and upper breast; and (d) absence of rufous or buff pigmentation on the secondaries or rectrices (Fig. 1).

Here I present a synopsis of the critical steps of the hybrid diagnosis. The pool of potential parental species may be quickly narrowed by focusing on the white ventral plumage of *salvini.* Among the potential parental species that occur in Sonora, Mexico, only *Amazilia violiceps* possesses white ventral plumage from chin to undertail coverts. Bluish-green spotting on the lateral margins of the chin, throat, and breast feathers of *salvini* were inherited from the other parental species. Both *Amazilia beryllina* and *Cynanthus latirostris* have green or bluish-green plumage from chin to upper breast. Because brown or reddish-brown pigments appear to exhibit consistent penetrance in hummingbird hybrids (Banks & Johnson 1961, Graves & Newfield 1996), *A. beryllina* can be eliminated from further consideration because the secondaries and rectrices of *salvini* lack buff or rufous pigment. Only one pair of species (*A. violiceps* × *C. latirostris*) could have contributed the unique combination of characters exhibited by *salvini* (Appendix 1).

Hybridization of *Amazilia violiceps* with any of the small gorgeted species (i.e., *Calypte annae, C. costa, Selasphorus platycercus, S. rufus, S. sasin, Stellula calliope, Archilochus alexandri, Calothorax lucifer*) would likely produce offspring with one to many iridescent gorget feathers (Graves & Zusi 1990; Graves 1996, 1999a). In a similar fashion, *Lampornis clemenciae* (brilliant gorget and large white tail spots), *Eugenes fulgens* (brilliant gorget and black breast and abdomen), *Hylocharis leucotis* (white postocular stripe and black chin and auriculars), and *Heliomaster constantii* (brilliant gorget and semi-concealed white rump patch) are unlikely to be a parental species because they each possess a suite of plumage characters not observed, even as traces, in *salvini.*

As a second step, I tested the restrictive hypothesis with an examination of size and external proportions (Fig. 2). Measurements of trochiline hybrids fall within the mensural ranges exhibited by their parental species as a consequence of a polygenic mode of inheritance (Banks & Johnson 1961). Measurements of *Amazilia violiceps elliot*i and *Cynanthus latirostris* overlap in four of the seven characters and the percent difference in character means is modest (larger species divided by smaller): wing chord (8.3%), bill length (5.4%), R1 (18.5%), R2 (14.0%), R3 (5.2%), R4 (0.3%), and R5 (5.9%). Measurements of *salvini* fall at or between the character means (or 1.0 mm less than the mean value for R4 of *A. violiceps*) of the postulated parental species, and, in several cases, approximate the values predicted by least squares regression. Rectrix color values in *salvini* fall between

Table 2.—Minima, maxima, and means (± standard deviation) of opponent color coordinates (*L, a, b*) of rectrix 1 (RI) of adult males of *Amazilia violiceps ellioti, Cynanthus latirostris magicus* and a probable hybrid, *Amazilia violiceps ellioti* × *Cynanthus latirostris magicus* (= type of *Cyanomyia salvini* Brewster, 1893; MCZ 224, 124).

		L			−*a*/*a*			−*b*/*b*		
		Lightness			Green/red			Blue/yellow		
		Min.	Max	Mean ± SD	Min	Max	Mean ± SD	Min.	Max	Mean ± SD
Amazilia violiceps	*N* = 19	25.2	32.2	29.8 ± 1.9	−1.7	3.2	0.7 ± 1.4	5.5	13.5	10.6 ± 1.8
Cynanthus latirostris	*N* = 14	13.6	20.2	16.9 ± 1.7	−0.3	4.4	1.9 ± 1.4	−4.3	1.6	−1.6 ± 1.8
Cyanomyia salvini				22.2			−1.6			7.7

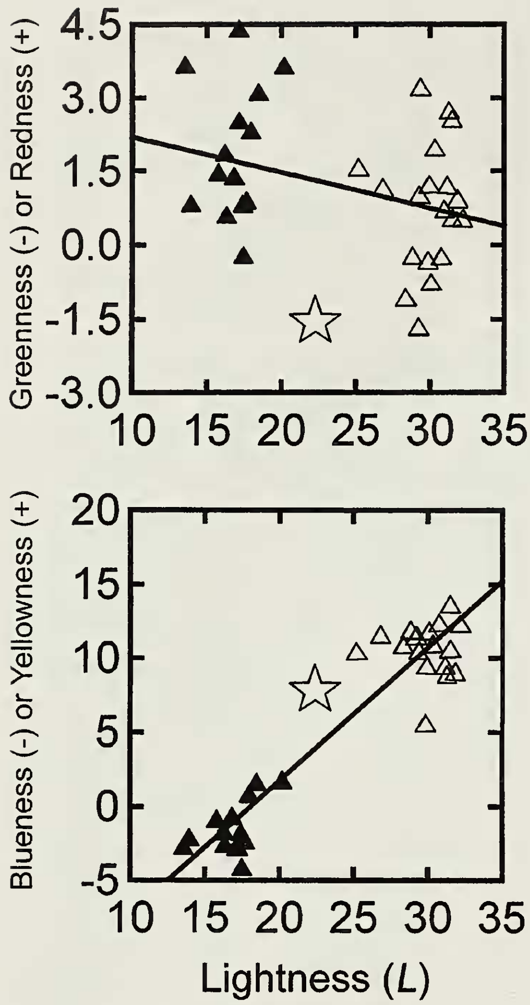

Fig. 3. Bivariate relationships of *L, a, b* color coordinates: *Amazilia violiceps ellioti* (hollow triangle), *Cynanthus latirostris magicus* (▲), and a probable hybrid (☆), *Amazilia violiceps ellioti* × *Cynanthus latirostris magicus* (= type of *Cyanomyia salvini* Brewster, 1893; MCZ 224,124).

the character means of the postulated parental species (Table 2, Fig. 3).

In summary, evidence obtained from plumage color and pattern, as well as from external size and shape, is consistent with the hypothesis that *Cyanomyia salvini* is an intrageneric hybrid between *Amazilia violiceps ellioti* and *Cynanthus latirostris magicus,* whose breeding ranges overlap extensively in northwestern Mexico. *Cyanomyia salvini* Brewster, 1893, is thus available in taxonomy only for the purposes of homonymy.

Acknowledgments

I thank Richard Banks and Richard Zusi for reviewing the manuscript, Doug Causey, Alison Pirie, .and Jeremiah Trimble (Museum of Comparative Zoology, Harvard University) for permission to study the type of *Cyanomyia salvini,* David Hafner (Occidental College) for specimen loans, Tom Schulenberg for tracking down the Bishop Collection specimen, and John Bates (Field Museum of Natural History) for lending it. Travel was supported by the Alexander Wetmore Fund, Smithsonian Institution.

Literature Cited

Banks, R. C., & N. K. Johnson. 1961. A review of North American hybrid hummingbirds.—Condor 63:3–28.

Bishop, L. B. 1906. *Uranomitra salvini* in Arizona.—Auk 23:337–338.

Boucard, A. 1893. Genera of humming birds, part 2. Published by the author, London.

Brewster, W. 1893. Description of a new hummingbird from northern Mexico.—Auk 10:214–215.

Cory, C. B. 1918. Catalogue of birds of the Americas, part 2, No.1.—Field Museum of Natural History Zoological Series 13:1–315.

Friedmann, H., L. Griscom, & R. T. Moore. 1950. Distributional check-list of the birds of Mexico, part 1. Pacific Coast Avifauna No. 29, 202 pp.

Goldsmith, T. H., & K. M. Goldsmith. 1979. Discrimination of colors by the black-chinned hummingbird, *Archilochus alexandri.*—Journal of Comparative Physiology A 130:209–220.

Graves, G. R. 1990. Systematics of the "green-throated sunangels" (Aves: Trochilidae): valid taxa or hybrids?—Proceedings of the Biological Society of Washington 103:6–25.

———. 1996. Diagnoses of hybrid hummingbirds (Aves: Trochilidae). 2. Hybrid origin of *Eriocnemis soderstromi* Butler.—Proceedings of the Biological Society of Washington 109:764–769.

———. 1998. Diagnoses of hybrid hummingbirds (Aves: Trochilidae). 6. An intergeneric hybrid, *Aglaiocercus kingi* × *Metallura tyrianthina,* from Venezuela.—Proceedings of the Biological Society of Washington 111:511–520.

———. 1999a. Diagnoses of hybrid hummingbirds (Aves: Trochilidae). 7. Probable parentage of *Calliphlox iridescens* Gould 1860.—Proceedings of the Biological Society of Washington 112:443–450.

———. 1999b. Diagnoses of hybrid hummingbirds (Aves: Trochilidae). 8. A provisional hypothesis for the hybrid origin of *Zodalia glyceria* (Gould, 1858).—Proceedings of the Biological Society of Washington 112:491–502.

———, & N. L. Newfield. 1996. Diagnoses of hybrid hummingbirds (Aves: Trochilidae). 1. Characterization of *Calypte anna* × *Stellula calliope* and the possible effects of egg volume on hybridization potential.—Proceedings of the Biological Society of Washington 109:755–763.

———, & R. L. Zusi. 1990. An intergeneric hybrid hummingbird (*Heliodoxa leadbeateri* × *Heliangelus amethysticollis*) from northern Colombia.—Condor 92:754–760.

Griscom, L. 1934. The ornithology of Guerrero, Mexico.—Bulletin of the Museum of Comparative Zoology 75:368–422.

Howell, S. N. G. & S. Webb. 1995. The birds of Mexico and northern Central America. Oxford University Press, Oxford, UK, 851 pp.

Hunter, R. S., & R. W. Harold. 1987. The measurement of appearance, 2nd edition. Wiley, New York, 411 pp.

Peters, J. 1945. Check-list of birds of the world, vol. 5. Museum of Comparative Zoology, Cambridge, Massachusetts, 306 pp.

Phillips, A. R. 1964. Notas sistematicas sobre aves Mexicanas, III.—Revista de la Sociedad Mexicana de Historia Natural 25:217–242.

Ridgway, R. 1911. Birds of North and Middle America. Bulletin of the United States National Museum 50, part 5.

Sibley, C. G., & B. L. Monroe, Jr. 1990. Distribution and taxonomy of birds of the world. Yale University Press, New Haven, Connecticut, 1111 pp.

Simon, E. 1921. Histoire naturelle des Trochilidae (synopsis et catalogue). Encyclopedia Roret, L. Mulo, Paris.

Weller, A.-A. 1999. Violet-crowned Hummingbird, *Agyrtria violiceps*. P. 599 *in* J. del Hoyo, A. Elliott, & J. Sargatal, eds., Handbook of the Birds of the World, vol. 5. Barn-owls to Hummingbirds. Lynx Edicions, Barcelona, 759 pp.

———, & K.-L. Schuchmann. 1997. The hybrid origin of a Venezuelan trochilid, *Amazilia distans* Wetmore & Phelps 1956.—Ornithologia Neotropical 8:107–112.

Appendix 1

Comparative description of selected characters of adult male *Amazilia violiceps ellioti*, *Cynanthus latirostris magicus*, and a probable hybrid, *A. violiceps ellioti* × *C. latirostris magicus* (= *Cyanomyia salvini* Brewster; MCZ 224,125). Descriptions of structural colors are unusually subjective, as color seen by the observer varies according to the angle of inspection and direction of light. For this reason I use general color descriptions.

The forecrown and crown of *violiceps* exhibit brilliant bluish-purple iridescence when viewed head-on in direct light. The remainder of the dorsum from hindneck to the rectrices is grayish-olive; the transition between the purple crown and olive hindneck is abrupt. The back, shoulders, upper tail coverts, and central rectrices are faintly glossed with silvery-green when viewed head-on. The rectrices are unmarked.

Feathers of the forecrown and crown of *latirostris* (to a point immediately posterior of the eyes) are dark green, margined with bronze giving the forehead and frontal part of the crown a dull appearance. The remainder of the dorsum from hindcrown to rump is glossy green (showing scattered bluish-green, brilliantly iridescent feather barbs when viewed head-on). Uppertail coverts are darker, contrasting slightly with the green rump and the bluish-black rectrices. The outer two or three pairs of rectrices (R3, R4, R5) are narrowly tipped with gray.

The crown of *salvini* is intermediate in appearance between that of *violiceps* and *latirostris*, showing a mixture of deep blue, purplish-blue iridescence, becoming greener toward the posterior of the coronal area. The intensity of iridescence increases posteriorly from the forecrown to center of the crown (viewed head-on). This bluish-green iridescence at the posterior edge of the coronal area blends into deep bluish-green on the hindneck and back, changing to dull green on the lower back and rump. The back and scapulars of *salvini* appear bluer than those of either parental species. This seems to be another example of the "bluing" phenomenon observed in some hummingbird hybrids (Graves 1998, 1999b). The intensity of iridescence on the lower back of *salvini* is intermediate between that observed in the postulated parental species. There is no appreciable contrast between uppertail coverts and rectrices in *salvini*. The rectrices are intermediate in color between those of *latirostris* and *violiceps* (Table 2). The outer rectrices (R4, R5) of *salvini* are worn and appear to be retained from a subdefinitive plumage. R1 and R2 are fresh and unworn, whereas the tip of R3 is slightly worn. Wing coverts and flight feathers of *salvini* are intermediate in color and degree of melanism to those of *violiceps* and *latirostris*.

The ventral plumage of *violiceps* is snowy white from chin to undertail coverts. Feathers on the chin, throat, and upper breast are pure white to the base, with only a few pale gray barbs at the base of the rachises.

The chin and upper throat of *latirostris* are deep purple (extending laterally to the auriculars and eyering), blending into dark bluish-green on the lower throat; this latter color continuing posteriorly to the vent. A few feathers in the chin are fringed with white. Feather disks from chin to vent exhibit iridescent highlights when viewed head-on. Vent feathers are white. Undertail coverts of *latirostris* are gray, paling to white at the distal margins (most coverts are gray along the rachis to the tip). Some shorter coverts have an oval gray subterminal spot.

The chin and throat of *salvini* are white but basal feather barbs are much grayer than in *violiceps*. The auriculars are iridescent purple and greenish-purple (posteriorly). Feathers at the sides of the throat have purple (anterior) or purplish-green (posteriorly) subterminal bars, imparting a spotted appearance to the sides of the throat. This spotting coalesces on the sides of the breast to form an incomplete pectoral band formed of white feathers with large subterminal greenish-blue or greenish-purple disks. The sides of *salvini* are dark bluish-green (about the same color as in *latirostris*). The tendency toward an incomplete pectoral band is present in *violiceps* in the form of grayish-olive sides, with scattered weakly iridescent, pale bluish-green feather disks. However, the medial extension of darker feather tips observed in *violiceps* never reaches the extent observed in *salvini*. The few undertail coverts remaining on the specimen of *salvini* are pure white.

The bill of *violiceps* is dull grayish-yellow (red in life) tipped with dark brown or blackish-brown ($<15\%$ of the bill length). Bill color in *latirostris* is similar but the dark tip is more extensive. The pattern of pigmentation in *salvini* is intermediate of that observed in adult male specimens of *violiceps* and *latirostris*.